

Technology and change

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Summary

Technology affects education through teaching, research, desktop publishing, rapid communication, management decision-making and administration, to mention but a few impacts. In this paper Arthur Sale, Professor of Information Science at the University of Tasmania, discusses the ways in which the University's Computer Policy Committee has sought to introduce technological change in a rapid and controlled manner over the last five years. As an expert computer scientist, Professor Sale will also discuss future developments in information technology and its likely impact on tertiary institutions in the coming decade.

1 Background

In this paper I am going to take up an exposed position - I want to talk to you about successful strategies and failures thereof that I have used in the University of Tasmania, as well as forecasting where technology-driven changes will take place in the future of this University. Why I describe this as an exposed position is not because I will be making technological forecasts, for most of you will have forgotten them by the time I might be proved wrong, but because it is relatively unusual for a university professor to describe the machinations by means of which a result is achieved. Why I am willing to take the risk may become apparent in the course of this address.

A very brief background is necessary to set the scene for the case studies I will describe. The University of Tasmania is Australia's fourth university and was founded in 1890. It has 5500 students and is the only university in the State of Tasmania. Because of its age it has a traditional university structure with faculties and departments. The Faculties and Faculty-like bodies include Agricultural Science, the School of Art, Arts, Economics & Commerce, the Centre for Education, Engineering & Surveying, the Centre for Environmental Studies, Law, Medicine, the Conservatorium of Music, and Science: just about a bit of everything except Veterinary Science or Architecture.

In recent years the power base of the University has tended to be concentrated in departments with faculties exerting very little financial power and only a modest academic filtering function. The centralist authority of the Professorial Board has been diluted by growth in its membership due to the democratization movement of the 1970s (it contains 70 members from a full time academic staff of around 300), and has to some extent devolved to its major committees. They however have to make decisions which affect some 33 departments and find it difficult to tread the fine line between being overwhelmed with detail and on the other hand taking decisions based on gross generalizations. The picture you should have, going back some five years, is of a university with semi-autonomous departments under loose financial control from a number of funds-oriented committees. Except at department level, and then dependent on the particular Head, planning beyond an annual horizon is almost non-existent.

Five years ago, then, it was realized that the University's *Computing Centre* had gradually lost contact both with the University generally and with progress in computing technology. With some added management problems, the Vice-Chancellor established a *Review of Computing Policy*. Boldly, the Review Committee was made very small, composed of two Professors and a Member of Council noted for his support for innovation.

Such reviews of computing policy have by now become quite commonplace in Australian universities; this one pre-dates most of them. The review report made a number of significant recommendations, all of which were accepted by the University and put into place immediately. Significantly the review did not produce detailed recommendations to fix the problems that had led to its establishment, apart from reorganizing the senior management of the Computing Centre. Rather it set in place a new structure and said, in effect, that the Computing Policy Committee had the responsibility of tackling the problems and living with the consequences. Briefly, the recommendations may be summarized as follows:

- the former large *Computing Centre Management Committee* and its *User Liaison Committee* were abolished; and
- a *Computing Policy Committee* was established with a membership of four initially, later growing to five;
- the Computing Policy Committee's terms of reference were written to include information technology policy formulation for the University, management overview, technology monitoring and facilitation of technological change.

2 Case Studies

2.1 Strategic planning

Almost the first decision made was to put the computing equipment purchasing policy onto a three-year plan. Strategic plans are now becoming fashionable, but were treated with reserve by the University community then.

The key to the triennial plan was to forecast the major decisions that would be made over the period. In the case of known problems like the replacement of the university central computing, this was relatively easy. Major purchases on behalf of departments were planned on the basis of a judgment arising from submissions, while minor purchases were estimated on the basis of past history. The hardest part was to carry out a technology forecast and to include sums for predicted needs, which at the time seemed futuristic or uncertain.

The sums needed exceeded the likely amount to be available, so the Committee took another bold step. It asked the University to commit to it 45% of the equipment grant for the next three years, on condition that no computing equipment was bought from equipment funds outside of the Committee's overview. The latter condition appealed to users of traditional forms of equipment who could see a ceiling on the rising computing expenditure. The financial managers agreed with the argument that value judgments were easier to make within the computing budget than outside it, as it was exceedingly difficult to compare the merits of a grand piano with that of a transmission electron microscope, and hoped for better consideration of individual cases in the computing budget. In brief, the University committed itself to the 45% figure. The Committee accordingly implemented a plan in which the following facets had a place:

- It was regarded as desirable that the University's central computing maintain a *two-supplier* policy. Avoidance of being 'locked-in' to a single supplier was seen as desirable for users, though it was realized that this would impose extra costs on the Computing Centre.
- The central computing equipment should not be concentrated in a single computer, whose replacement would create large cash-flow problems. In addition, such a solution is technologically obsolete for at least half of its useful life. The plan called for at least two largish computers of approximately equal power, each to be replaced at the mid-point of the lifetime of the other. In this way a rolling replacement was possible, and at least half of the capacity would be derived from a technologically new machine.
- Provision was made for a trend to decentralized facilities, and for a declining percentage of the University's computing power to be provided directly by the Computing Centre. This clearly called for a re-evaluation of the Centre's role.

2.2 Technological push for planning

The Committee also sought to use special purpose grants as both carrots and Trojan horses. While most funds in the University are doled out in predictable and necessary ways, the Committee's planning processes allowed it to free up a modest amount which could be allocated outside the student-driven allocation processes. These have been allocated with only a modest nod towards the equity principle, and a much larger consideration of two factors: the capability of the recipient to use the facility thus funded to a high degree of usefulness and utilization, and the capacity of the facility to generate induced technological change in the staff involved, the courses and the students.

The first case of this grant-push process was applied to the University's Centre for Education, which had expressed a wish for a computing laboratory. The Committee unexpectedly gave the Centre the necessary funds, together with refurbishment of its building to create a suitable environment, and controlled the selection process. The process of

selection of equipment which involved interaction with technical experts acted as an educational process for the staff involved. In the ensuing years, both the need to justify the existence of an expensive facility and the seduction of the facilities it offered have continued the educational and technological change processes within the Centre for Education. Yet the quality of the original argument for it did not justify the expenditure.

Since that first venture into backing speculative ventures the Committee has embarked on other grant projects of risk, including:

- a laboratory for Mathematics (with somewhat lower but still significant risks and development value;
- a substantial computer-aided design laboratory for the engineering disciplines (not risky, but with relearning involved);
- laboratories for Sociology, Psychology and Geography (low risk, presently in the planning and purchase stages); and
- a common use facility in the Library (low risk of usage failure, but a high uncertainty of operational features).

In brief, the use of special purpose grants has proved to be an effective method of deliberately inducing technological change. However, it has been important that technical experts, including members of the Committee, influence the choice and installation of equipment. It is even more important that the recipients be made to plan their usage and to subsequently take responsibility for the facility.

2.3 Office automation

At about the same time, the Committee drew the University's attention to an barely perceptible problem with word-processors, of which there were only three in the University. These involved standardization, training, communications and ergonomics. As a result of the Committee's efforts, the University also agreed to allocate 5% of its equipment funds per annum for the Committee to allocate to worthy office automation projects. This amount **has been used** to equip secretarial staff with wordprocessors, and has proved to be a reasonable amount for this purpose. The Committee budgets for around \$1000 per workstation for improving the workplace, though this is not always required.

The funds are expended on the basis of apparent need based on the document preparation load, the attitude of the head of the section, and the attitude of the secretary involved. The equipment can be redeployed by the Committee under appropriate conditions, and has been in some cases as newer more suitable equipment became available for departments which were leaders (*eg* Physics). The department undertakes to pay maintenance and running costs and to have new secretarial staff properly trained. Only modest resistance by secretarial staff has been observed during this period, as those who do not wish to be involved need not be.

In addition, since the Committee drew the University's attention to the emerging RSI syndrome, an RSI Working Party has been established. Its main thrusts have been in preventative measures including the education of heads and secretaries of the perils of overuse, and of introducing or maintaining variety in the work tasks. It was too much to expect that all incidence of RSI would be avoided, but it has not been a severe problem.

2.4 ACSnet and Spearnet

One of the slow ideas to take off has been electronic mail (enwio and the formation of electronically linked workers. While this has been an idea of potentially enormous value, only computer scientists have used it extensively. The reason for this is not hard to seek: to use electronic mail at its present state of development, . a user has to be virtually a daily user of computing facilities. Not until email is integrated with the telephone or some other standard piece of office furniture will this change. Nevertheless there are important signs that change is occurring.

The Department of Information Science found the Computing Centre sceptical of the value of electronic mail, so it had to develop the facility itself. The initial facility provided was a layer of software called *ACSnet*, which provided access to data transport over the CSIRO network. Email sent over ACSnet is forwarded from computer to computer until it reaches its destination. Each node and person has an electronic address. For example, my electronic address if you want to use it is *ahjs@tasis.oz*; on other words A.H.J.Sale on the *tasis* computer in the oz (Australia) domain. To give

the flavour of this I recently received a 20 page email letter from a computer scientist in Washington USA the same day it was sent, I replied, and I received a reply to the reply all within the same day. One of my staff is writing a book with a colleague in the UK, using email to correspond; others use the facility to participate in national and international research groups.

The encouraging sign is that the Computing Centre and other users are beginning to become aware of the value of email. My secretary now knows how to use it and collect email on my behalf. In 1986, we have also seen **CSIRO** initiate a much improved service called *Spearnet*, which provides a packet-switching transport service over Austpac instead of a store- and-forward service. The University has become one of the initial users at a cost of around \$ 10 000, in order to be ready for an increase in the level of use. The example is a good one to illustrate the value of being a pioneer in experimentation and thus facilitating subsequent transfer of technology.

2 S Consortium

The University was offered participation in a Consortium arrangement with Apple computers about two years ago, whereby Apple would supply Macintosh personal computers to the University at dealer prices. The University could use these for its own purposes or resell them to students and staff. In return Apple expected to get exposure of their computers and more importantly a return from those universities that engaged in serious computer R&D. To get the University to agree to this in the commercial timeframe took a lot of hard work, but it was done.

This exercise has been spectacularly successful. The computers bought have been split in approximately equal proportions between the University, staff, and students. In other words, the value of University investment in personal computers has been multiplied by around 3-4 by personal purchases and the discount policy.

It has also been notable that the penetration of Macintosh computers has been driven by a self-mobilized army of enthusiasts. For example, a senior administrative officer was loaned a machine over a weekend and next week there was an order for two from quite different sections of the Administration. We now have a support group of two people in the Computing Centre and most of the time of another two simply dealing with PC issues. The Centre has re-oriented itself from being a computing service provider to being an advice provider.

2.6 Disasters and lesser mistakes

It should not be thought from the anecdotes given that no mistakes have been made, nor even that a few cannot be classified as disasters. In the best managed committee there will be errors of judgment and it is important that those involved have the opportunity to recover from them. Only repetition of mistakes or a high frequency of errors is disastrous. The University environment tends to be unforgiving in this way, as mistakes once made are remembered for a very long time, and the norm is to minimize risk taking.

It is difficult to change this perception of university management, but it is clear that it needs to become more tolerant of errors, and more able to take decisions on the basis of incomplete information. I believe that such changes are taking place, rather slowly, both as older members of staff retire and as decisions with risk gradually become more acceptable. This itself could make a whole new address in itself.

3

Our future

Speculation as to the nature of future change is always risky. However, it has been my observation that this is not the main problem. The main problems are :

- many decision-makers tend to dismiss reasonably reliable technology forecasts as futuristic;
- it is much more difficult to predict the time-scale for a change than to predict the change itself.

In this part of my address, I want to draw attention to a few developments that I regard as having a very high probability of happening in the next decade. I note that the rate of technological change can best be observed in time reversal; my favourite example is the pocket calculator. Few educational administrators are prepared to plan for technological change seriously, while they are prepared to plan for the vagaries of governments and student preferences. Consider the following issues as important ones for the future :

- Battery operated calculators or computers (the terms are becoming interchangeable) now have the capacity to store substantial amounts of data (say 100 000 characters), and will soon have the capacity around 10 000 000 characters. The consequences of this for examination practices need consideration; open-book examinations in science subjects at least are likely to be the norm unless we decide to force students to use appropriate technology during the year but obsolescent technology during examinations.
- Work from home becomes more and more feasible, bringing with it problems of absenteeism by staff and consequent loss of face-to-face access by students and of monitoring and influence by heads of departments. On the other side, travel to campus may reduce for some students.
- Research interactions will increase between institutions through the use of electronic mail and facsimile, increasing when the two are integrated. Already interactions of this kind are very common in disciplines which have favourable conditions for its development. The distribution may involve national or international networking.
- Ownership of a personal computer will eventually reach the point of being a requirement for studentship, or provided with the status. Indeed, three institutions in the USA (Drexel University, Mississippi State Veterinary School, and Virginia Polytechnic) already insist that every student owns a Macintosh, while another nine highly recommend such ownership. In Australia, with its history of low tuition charges, this will take longer to take effect. However, since technology is halving in costs every two years, it will take of the order of ten years before a computer of the power of a Macintosh Plus reaches the cost of a contemporary textbook. Ignoring the probability that the cost of textbooks will have inflated, are we preparing for the effects this will bring?
- Integration of the telephone with electronic media is well advanced in research establishments. Shortly we shall see the ability to have store-and-forward messaging from digitized voice, and a full electronic mailbox indicated by lights, with possible replay. The saving in time from missed phone calls will ensure rapid adoption of the facility.
- Educational software is improving rapidly, but it will remain an adjunct to traditional teaching in tertiary institutions rather than replace it. Teaching applications with real potential will rather derive from the application of traditional computer uses such as word-processing, electronic spreadsheets, computer-aided design, file enquiry, simulation and modelling.
- There is increasing evidence that the ability to produce high quality documents through word processing and graphics engenders a greater pride in work, and a consequent higher quality. The advent of widespread desktop publishing in student assignments, student newspapers, and other activities will have a number of effects which are not difficult to predict. Spelling checkers are now widely available, syntax checkers are in use in research environments and cannot be far away. These will have effects on the nature of the written word, and consequently on assessment, to give a small example.

4 Retrospective

4.1 *The Law of Small Numbers*

I wish to propose a Law of Small Numbers which applies to university committees:

A committee whose membership is less than six is unstable, and tends to either attract extra members or to be disbanded or absorbed.

The law seems to be true here at least. There are few examples of standing committees which break it. The Computing Policy Committee itself started out with four members and attracted a fifth after one year. There has been a latent feeling amongst the university community that it remains too small. Three factors have tended to protect it from the consequences of the Law of Small Numbers:

- it is not an attractive committee to be on as it meets every month and members are expected to work quite hard and accept corporate responsibility,

- why change something that is perceived as successful, and
- vigilance.

The success of the Committee may be partially traced to its small size. This enables it to meet at relatively short notice to transact urgent business, and it means that the posturing that sets in with committees of 10 members or more is avoided. As a consequence the members take a University view; they also accept responsibility for their decisions which are always taken by consensus. In five years we have never yet recorded a vote. In retrospect the establishment of a small tightly knit committee with carefully controlled membership and terms of reference was an important factor in the developments I have described.

4.2 Incremental change

The anecdotes cited in this paper are strongly slanted towards achieving incremental change, within the limits that the institution can accept. Large institutions are innately conservative and slow to change. Universities are especially slow to change, for otherwise they are simply too vulnerable to a poorly judged notion that one of their members may throw up. The whole Faculty and committee structure provides the necessary community consultation and delay for an ill-considered proposal to be filtered out.

Many people know this, but fewer accept that the pressure for change in universities and colleges today is too high to be able to accept the delay mechanisms of the past. They are still needed, but with somewhat more ability to accept innovation and externally imposed change.

4.3 System factors

One of the most important strategies used has been what has been called the *infective model*. Demonstrate it in an appropriate and obvious context, and if it works then people will be lining up to copy it. There are of course several problems with this strategy. You have to find someone willing to be infected first, and the change needs to be one which has the capacity to start an epidemic.

This highlights the value to a university or college of an *innovation leader* and *change-agent*: a unit which is seen by all to be the risk-taker, and which is willing to act as an agent of technological change for those innovations which it pioneers. In this University my Department of Information Science has filled this role with respect to information technology. However, the problems of this should not be glossed over. First, the position of change-agent is an exposed one; it is subject to attack by those who would rather preserve the *status quo*, and by those who espouse the equity principle to an extreme. Maintenance of the change-agent status thus is wearing on the nerves. Secondly, and somewhat more difficult to cope with is the internal questioning within the change-agent: *Why do we spend so much time helping others?* The implication is that the staff would rather do research, or something else. It is thus essential that the majority of staff in a change-agent accept this as a legitimate and valued part of their role. It would be nice if it were also seen to contribute towards promotion, but that may be too much to ask for.

The second key strategy is to change the system parameters somehow, so that the outcome that is desired becomes more natural or more rewarded than the undesired ones. Examples can be found in the case studies I have cited, such as the way the 45% equipment share changed the ground rules to require departments requiring special grants to carry out a planning process and be able to justify their usage patterns to the Computer Policy Committee and the wider community. It is surprising when you come to analyse a particular situation just how many disincentives there are for rational behaviour, generally hangovers from an earlier period.

The third key strategy is what I call *passion for excellence*. Information technologists are well-known for their slapdash approach to products and process, and the trail of so are errors and products that never make it attests to it. It is vital to confidence in the enterprise to back winners, and to have a commitment to nothing but the best that can be achieved. A recent example of this is the advent of desktop publishing; it has been important for us to be able to use the technology in our correspondence in such a way that the university community saw that we cared about the presentation of what we wrote. One professor commented sourly *'Your letters always look as though they have been typeset'* with the implication that that was going too far. In fact they were typeset in our own office, but what he wasn't aware of was the avoidance of many insidious typesetter's infelicities that are part of a publisher's general knowledge but which we had to learn by reading and experimentation. The importance of this is highlighted by some of the visual atrocities perpetrated by beginning users of desktop publishing when they are let loose with a plethora of type fonts,

point sizes and layout options. The same can be seen in videotext frames, where beginners splash every colour of the rainbow onto every screen. There seems to be an urge to use it just because it is there, and it is usually only when this has worn off that sanity returns, usually after six months to a year. That is too long for a change-agent: it needs to adapt more quickly.

4.4 Change to Mission -oriented committees

One of the consequences of managing technological change in this University has been to highlight a change in the functions of committees. The Computing Policy Committee, despite its name, is involved in both policy and its implementation. It was one of the first in the University to signal a shift away from *funds-oriented* committees to *mission-oriented* committees. In brief, a funds-oriented committee exists to oversee the allocation and sometimes expenditure of a particular type of funds, while a mission-oriented committee has a particular mission as its reason for existence, ranging over a variety of funds in order to achieve this mission. Our Research Committee is currently engaged in turning itself over from funds-orientation to a mission-oriented role as part of a review of management practices but now hastened by the Commonwealth Government's interest in efficiency. The pleasant thing about a mission-oriented Committee from a Vice-Chancellor's position is that it is easy to see where the responsibility should be sheeted home. From the Chairman's point of view this is less comfortable, and the onus is then on him to acquire the resources to deliver.

The ways to change the nature of a committee in this way are a study in themselves. Increasing the frequency of meetings and making them both regular and reliable is important, as is producing good agenda and minutes. It is also important to share out work and to make sure everyone involved is aware of their individual responsibilities. The use of *ad hoc* working parties is especially useful in this regard.

4.5 Reliability

Reliability is a vital factor in management and especially so in dealing with technological change. It is simply essential to deliver when you say you will. Users faced with unreliable facilities or unreliable sources of equipment or advice simply give up.

Acknowledgment

In closing I wish to acknowledge the indebtedness that the activities that I have described owe to the Vice-Chancellor of the University of Tasmania. Thrown in at the deep end by having to implement some of the rough recommendations of the Review of Computing Policy in his first days at the University, he has exercised the prerogative of the Nelsonian blind eye whenever it was needed.